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Solution by G. B. M. ZERR, Ph. D., Parsons, W. Va.

Constant acceleration is a force that produces a constant increase in velocity. Gravity is such a force.

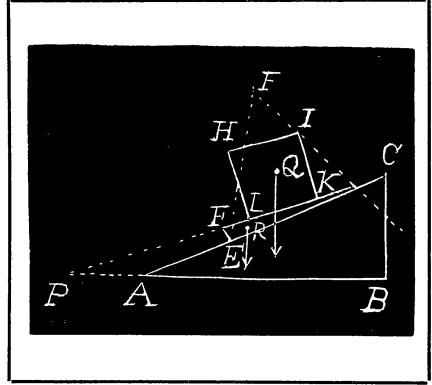
Let $\angle CBA = \beta$, the angle of inclination of the plane; $\angle FDE = \delta$, the angle of the wedge. Let ν = coefficient of friction between wedge FDE and body $HIKL$.

If $\tan DPB = \tan(\beta - \delta) > \nu$, the constant acceleration is

$$g[\sin(\beta - \delta) - \nu \cos(\beta - \delta)].$$

If $\angle FDE > \angle CAB$, then if $\tan(\delta - \beta) > \nu$, the constant acceleration is $g[\sin(\delta - \beta) - \nu \cos(\delta - \beta)]$.

Hence, the condition for constant acceleration of the body on the wedge, the wedge not slipping, is that the coefficient of friction between body and wedge be less than the tangent of the difference of the angles of plane and wedge or wedge and plane. This covers the case for angle of friction for wedge and plane greater than angle of inclination of plane. The opposite case would form an interesting problem.

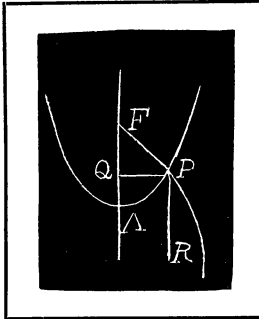


195. Proposed by J. EDWARD SANDERS, Reinersville, Ohio.

Particles slide from rest at the focus of a parabola, whose axis is vertical, down radius vectors, and are then allowed to move freely. Find the locus of the foci of their subsequent paths.

Solution by J. SCHEFFER, A. M., Hagerstown, Md.

Let PF be a radius vector $= r$, and $\angle PFA = \theta$. Let v be the velocity of the particle when leaving P . Draw PR parallel to AF . We find with reference to PR as the axis of abscissa, and P as origin of orthogonal co-ordinates, the equation



$$x = -\frac{\cos \theta}{\sin \theta} y + \frac{1}{2v^2 \sin^2 \theta} y^2;$$

$$\text{but } v^2 = 2gr \cos \theta, \text{ and } r = \frac{a}{\cos^2 \frac{1}{2} \theta}. \therefore v^2 = \frac{2ag \cos \theta}{\cos^2 \frac{1}{2} \theta}.$$

$\therefore$ Equation of curve

$$y^2 + \frac{4a \sin \theta \cos^2 \theta}{\cos^2 \frac{1}{2} \theta} y = \frac{4a \cos \theta \sin^2 \theta}{\cos^2 \frac{1}{2} \theta} x.$$

From this equation it follows that the co-ordinates of the vertex of this

parabola with reference to its axis are $\frac{a \cos^3 \theta}{\cos^2 \frac{1}{2} \theta}$ and $\frac{2a \sin \theta \cos^2 \theta}{\cos^2 \frac{1}{2} \theta}$, and its parameter $\frac{a \sin^2 \theta \cos \theta}{\cos^2 \frac{1}{2} \theta}$.

Denoting by x and y the current co-ordinates of this curve with reference to the axis of the given parabola, and the focus as origin, we find from the above

$$x = \frac{a \cos \theta + a \sin^2 \theta \cos \theta - a \cos^3 \theta}{\cos^2 \frac{1}{2} \theta} = \frac{a \sin 2\theta \sin \theta}{\cos^2 \frac{1}{2} \theta},$$

$$y = a \frac{\sin \theta - \sin 2\theta \cos \theta}{\cos^2 \frac{1}{2} \theta} = -\frac{a \sin \theta \cos 2\theta}{\cos^2 \frac{1}{2} \theta}.$$

By eliminating θ we get $(x^2 + y^2 - 4a^2)^2 (x^2 + y^2) = y^2 (x^2 + y^2 + 4a^2)^2$. Introducing polar co-ordinates ρ and ϕ , we get the simpler equation

$$\rho = \pm 2a \cot(45^\circ - \frac{1}{2}\phi) \text{ and } \rho = \pm 2a \tan(45^\circ - \frac{1}{2}\phi).$$

Also solved by G. B. M. Zerr.

AVERAGE AND PROBABILITY.

160. Proposed by J. F. LAWRENCE, A. M., Stillwater, Oklahoma.

Two points are taken at random in a triangle, the line joining them dividing the triangle into two portions. Find the mean value of that portion containing the center of gravity.

Solution by HENRY HEATON, Belfield, N. D.

The triangle may be considered equilateral (see Williamson's *Integral Calculus*, p. 355). Put $\triangle$ = area of equilateral triangle whose side = a . Let P be one of the points, $PD = y$ and $BD = x$. Let EPF be the line through the two points, and put $\angle BFP = \theta$ and $\angle BEP = \phi$. Then $\phi = \frac{2}{3}\pi - \theta$, $PF = y \operatorname{cosec} \theta$ and $DF = y \cot \theta$. The area of the elemental triangle $PFF' = \frac{1}{2} y^2 \operatorname{cosec}^2 \theta d\theta$. We will suppose the second point to be confined to this elemental triangle. Put $BF = z$. Then $z = x + y \cot \theta$, $BE = z \sin \theta \operatorname{cosec} \phi$, and area of triangle $EBF = \frac{\triangle z^2}{a^2} \sin \theta \operatorname{cosec} \phi$.

If $\theta < \frac{1}{6}\pi$ and F is confined to the line BC the area of the portion of the triangle containing the center of gravity is $\frac{\triangle}{a^2} (a^2 - z^2 \sin \theta \operatorname{cosec} \theta)$. The limits of z for this are $\frac{2}{3}y \sqrt{3} \sin \phi \operatorname{cosec} \theta$ and a . Those of y are 0 and $\frac{1}{2}a \sqrt{3} \sin \theta \operatorname{cosec} \phi$. If $\theta > \frac{1}{6}\pi$ and $< \frac{1}{3}\pi$, the line EF passes through O when $z = \frac{a}{3} (1 + \sin \phi \operatorname{cosec} \theta)$.